NAVY EXPERIMENTAL DIVING UNIT

DEPARTMENT OF THE NAVY
NAVY EXPERIMENTAL DIVING UNIT
PANAMA CITY, FLORIDA 32407

IN REPLY REFER TO:

NAVY EXPERIMENTAL DIVING UNIT

REPORT NO. 8-79

MK 12 SURFACE SUPPLIED DIVING SYSTEM HELIUM-OXYGEN EMERGENCY MODE STUDY

By

W. H. SPAUR
E. D. THALMANN
R. C. MAULBECK

November 1979

Approved for public release; distribution unlimited.

Submitted by:

W. H. SPAUR
CAPT, MC, USN
Senior Medical Officer

Approved by:

C. A. BARTHOLOMEW
CDR, USN
Commanding Officer

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER: NEDU REPORT NO 8-79	2. GOVT ACCESSION NO. / 3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle): MK 12 SURFACE SUPPLIED DIVING SYSTEM HELIUM-OXYGEN EMERGENCY MODE STUDY.	5. TYPE OF REPORT & PERIOD COVERED: FINAL rept. / 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): W. H. SPAUR, E. D. THALMANN, R. C. MAULBECK	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: NAVY EXPERIMENTAL DIVING UNIT, PANAMA CITY, FL 32407	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS: 12 12	12. REPORT DATE: NOV 1979 / 13. NUMBER OF PAGES
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)	15. SECURITY CLASS. (of this report): UNCLASSIFIED / 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

MK 12
DIVING SYSTEM
EMERGENCY MODE

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This experiment tested the duration that respirable gas would be available in the MK 12 helmet when gas supply from the umblical has been stopped. The emergency mode semi-closed recirculator operation was tested in 40°F (4.5°C) water in a wet chamber at depths of 390 and 80 FSW. The duration of reasonable life support was considered to be the time between shut-off of the umbilical supplied mixed-gas and the time when the helmet gas reached 3% SEV. The results indicate that approximately 8 min of adequate life support are available in the emergency mode.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE
S/N 0102-LF-014-6601

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

253 650

TABLE OF CONTENTS

Section	Page
TABLE OF CONTENTS	i
ABSTRACT	ii
Introduction	1
Methods	3
Results	4
Discussion	4
Figure 1. Mixed-Gas System Flow, Semi-closed	5
Figure 2. Mixed-Gas System Emergency Semi-Closed and Open Circuit Flow.	6
Figure 3. Emergency Bottle Supplied Semi-Closed Recirculator Duration of Life Support	7

ABSTRACT

This experiment tested the duration that respirable gas would be available in the MK 12 helmet when gas supply from the umbilical has been stopped. The emergency mode semi-closed recirculator operation was tested in 40°F (4.5°C) water in a wet chamber at depths of 390 and 80 FSW. The duration of reasonable life support was considered to be the time between shut-off of the umbilical supplied mixed-gas and the time when the helmet gas reached 3% SEV. The results indicate that approximately 8 min of adequate life support are available in the emergency mode.

EMERGENCY MODE TEST OF THE HELIUM-OXYGEN, MK 12 SSDS DIVING SYSTEM

Introduction

Four operating configurations are available with the MK 12 SSDS helium-oxygen mode. The operating modes are as follows: umbilical-supplied semi-closed recirculator, umbilical-supplied open circuit, emergency bottle supplied semi-closed recirculator, and emergency bottle supplied open circuit.

During normal operation of the semi-closed recirculator, mixed gas from the surface enters the recirculator through a non-return valve at the umbilical supply elbow (Figure 1). The surface console operator selects an overbottom pressure to the recirculator which maintains a 6.0 actual cubic foot per minute (ACFM) flow within the helmet. The volume of the mixed gas to the ejector is controlled with a four-turn ejector supply valve. The ejector supply valve is normally fully opened, but when closed can be used to isolate gas from entering the ejector nozzle. Mixed gas supplied to the low pressure manifold into the ejector cavity is moved by means of the Venturi effect. In the ejector throat the scrubbed gas and the new gas from the ejector nozzle are combined. After passing through the ejector throat, it then passes through a muffler consisting of a concentric tube designed to reduce noise. Mixed gas is then routed through a hose and hose connector into the helmet assembly. In the helmet, the flow path is through a one-way valve and distribution duct. The distribution duct is configured to minimize the effect of carbon dioxide build up. Gas returns to the recirculator through return ducts, a one-way valve, hose connector, and hose. A canister containing 12 pounds of High Performance Sodasorb scrubs the return gas of carbon dioxide.

An open circuit umbilical supply is used in the event of problems such as recirculator malfunctioning or flooding. The umbilical supply is fed through a by-pass directly into the helmet. Open circuit umbilical supply operation is achieved by opening the helmet supply valve and closing the ejector supply valve. The emergency supply valve would remain closed. This configuration uses 10 to 12 times more gas than the surface supplied semi-closed recirculator configuration.

The two mixed gas emergency configurations use the emergency bottle located in the recirculator. Mixed gas emergency semi-closed recirculation is utilized when the surface supplied mixed gas is lost or becomes contaminated and the recirculator remains operational. Emergency semi-closed mode is selected by opening the emergency supply valve (Figure 2). The ejector supply valve remains open and the helmet supply valve is closed. High pressure mixed gas is fed through a pressure reducer maintaining pressure at 30 psi overbottom while flowing. Gas then flows to the ejector supply valve, ejector nozzle throat, and muffler assembly into the helmet. Returning gas drawn from the helmet through the canister is scrubbed of carbon dioxide and combined with the emergency bottle gas in the ejector nozzle throat assembly. Recirculation of the mixed gas reduces the demand on the emergency bottle mixed gas.

Selection of the open circuit emergency operation is accomplished by opening the emergency supply valve, and the helmet supply valve, and closing the ejector supply valve. High pressure mixed gas from the emergency bottle is regulated at 30 psig overbottom pressure while flowing and fed through the by-pass to the helmet. The helmet diffuser assembly distributes the mixed gas through the open circuit emergency operation. The duration of gas

supply in this open-circuit helmet ventilation mode is too brief for this to be considered as a functional emergency mode.

This experiment was designed to test the duration that respirable gas would be available to the helmet when gas supply from the umbilical has been stopped. The emergency mode was tested in the semi-closed recirculator operation and not in the open circuit mode from the emergency bottle.

Methods

Three experienced U.S. Navy male divers served as subjects. The divers were thoroughly familiar with the characteristics of the MK 12 SSDS. These studies were performed in the final days of a 390 FSW saturation dive dedicated to testing of the MK 12 SSDS. Two studies were conducted at 390 FSW and one study was conducted at 80 FSW during the saturation decompression.

All studies were performed in 40°F (4.5°C) water in a wet chamber of the Navy Experimental Diving Unit. The divers wore a prototype MK 12 SSDS and were thermally protected by a MK 12 hot water outergarment. The carbon dioxide absorbent was High Performance Sodasorb. The supply gas was 94% helium-6% oxygen (oxygen partial pressure (P_{O_2}) 584 millimeters of mercury at 390 FSW). The gas mixture was delivered to the ejector manifold via 600 ft of MK 12 umbilical hose at an overbottom pressure of 50 psi which produced helmet ventilation of 6 ACFM.

The diver was dressed in the MK 12 SSDS instrumented for these studies. He then descended into the wet chamber and had a chest depth of approximately 10 ft of water. With a winch lift harness in place, he stood directly in front of the descending ladder.

A continuous analysis of helmet carbon dioxide and oxygen was measured by venting gas samples via an 1/16" i.d. tube at a flow rate of 200 cc/min.

Upon direction from the dive supervisor, the diver closed the quarter-turn ball valve between the umbilical and recirculating whip. This action was designated as the start time. The diver then opened the MK 12 emergency bottle and breathed normally until the bottle was depleted. At that time, the diver shut the helmet exhaust valve and continued to breathe off the helmet gas. The CO_2 level in the helmet was monitored closely, and when the level reached 3.0% SEV, the divers' umbilical supply was restored and he ventilated the helmet. The duration of reasonable life support in the emergency mode was considered to be the time between shut-off of the umbilical-supplied mixed gas and the time when the helmet gas reached 3% SEV.

Results

Figure 3 is a graph of the helmet CO_2 versus time. In each study the emergency bottle flow stopped at 6 1/2 min. At 390 FSW, the duration that respirable gas was available to the diver was 8 min 25 sec and 7 min 45 sec. At 80 FSW, the duration was 8 min 25 sec. Emergency bottle pressures at the start of the experiments were 2200 psi for the first experiment, 2300 psi for the second, and 2500 psi for the third at 30 FSW.

Discussion

The studies of the emergency bottle supplied semi-closed recirculator indicate that rising helmet CO_2 limits the duration of adequate underwater breathing apparatus life support when gas supply from the umbilical has ceased. Insufficient data is available from this study to determine the effect of depth on gas supply duration, but calculated durations indicate that depth would have no great effect. Only 3 experiments were conducted, but the results indicate that approximately 8 min of adequate life support are available in the emergency mode.

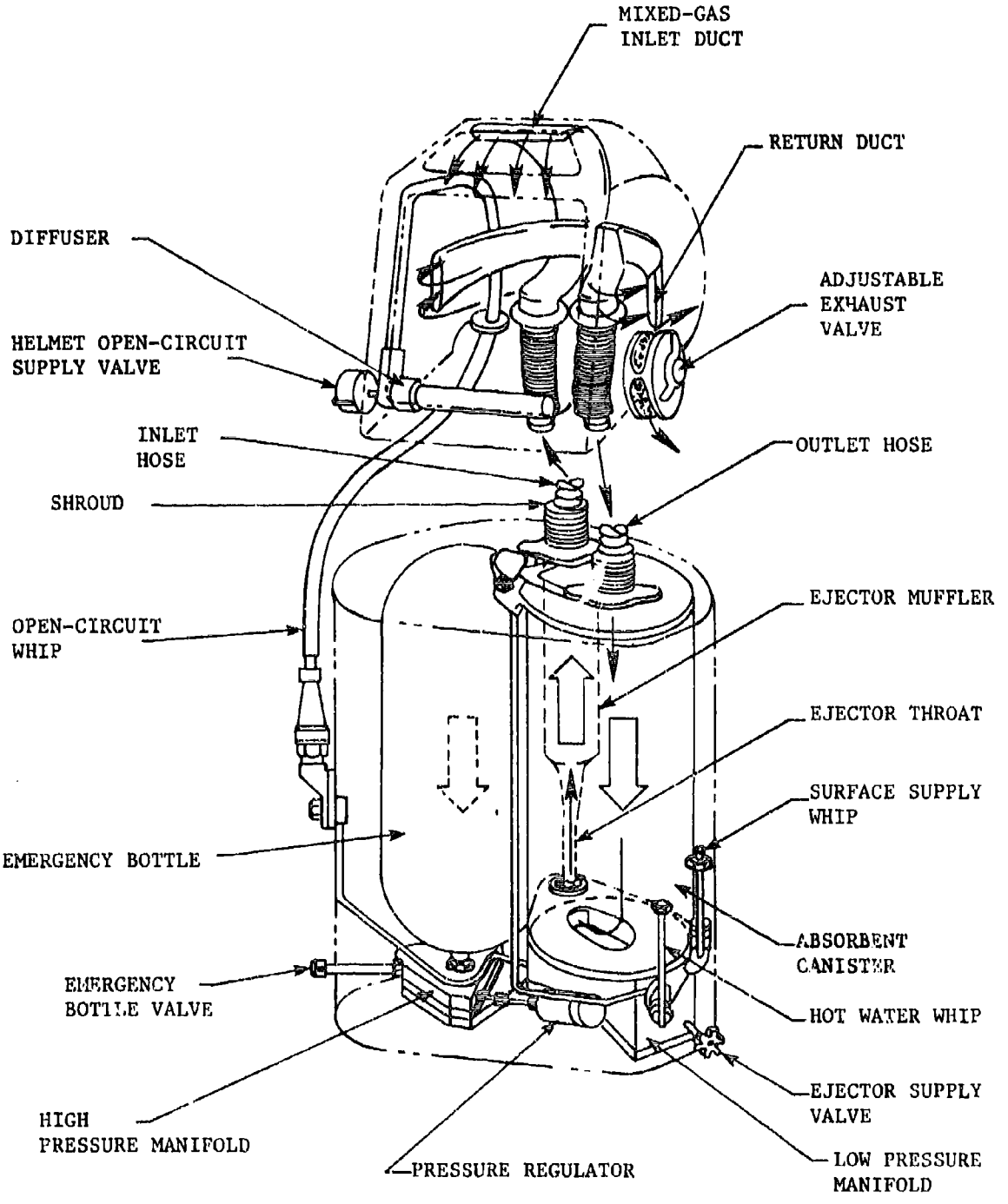

Figure 1. Mixed Gas System Flow, Semi-closed

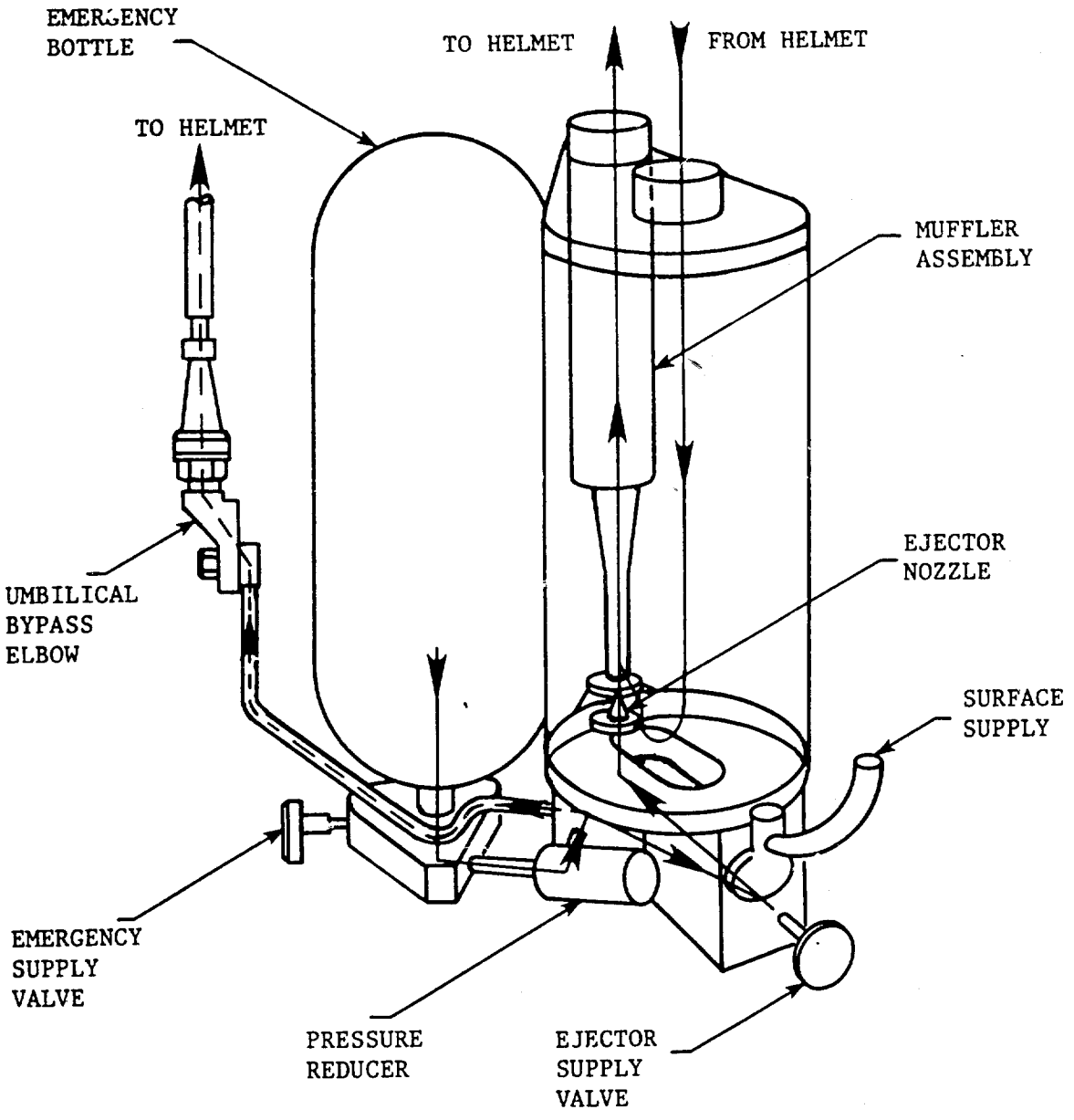

Figure 2. Mixed Gas System Emergency Semi-Closed and Open Circuit Flow.

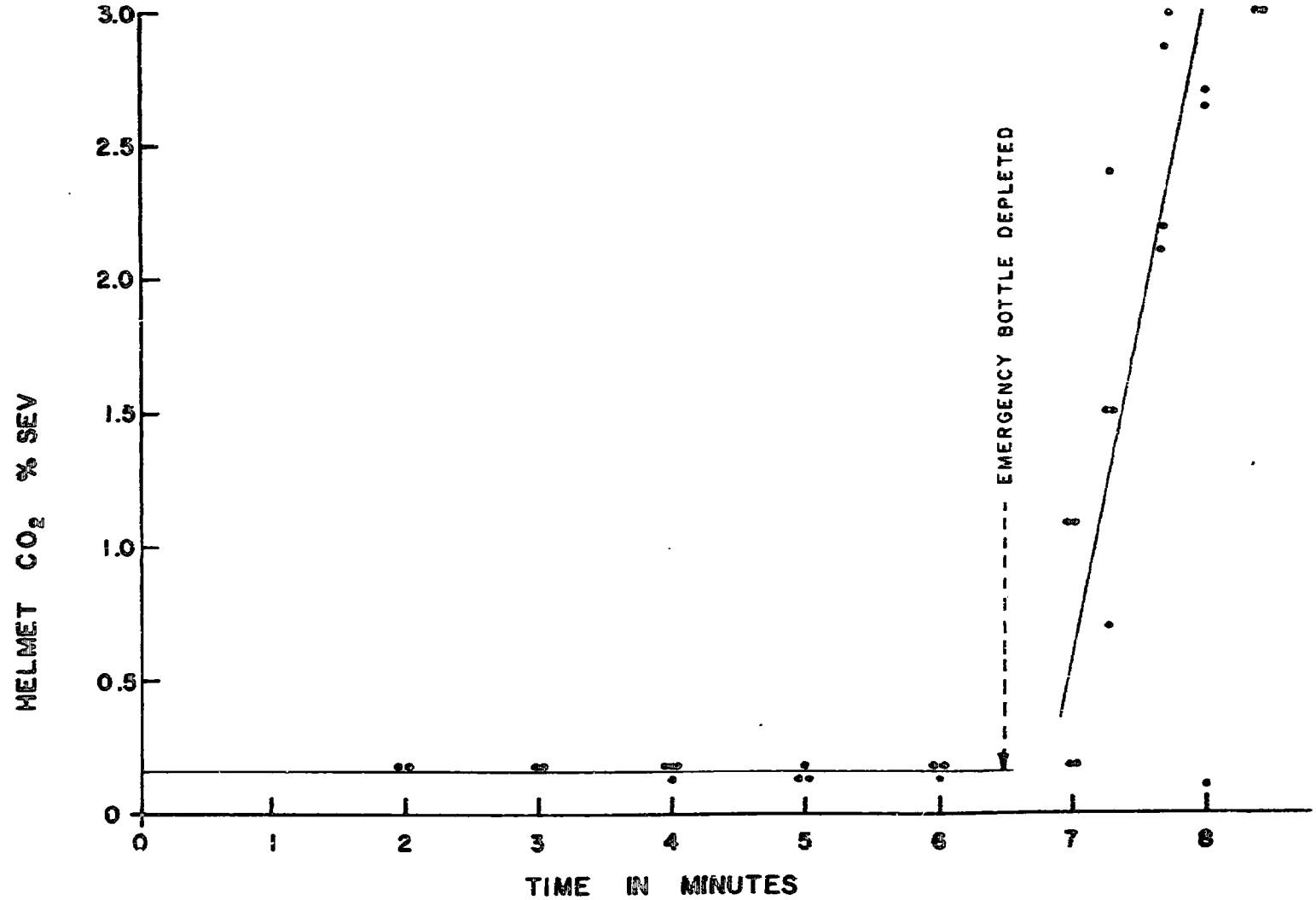

FIGURE 3. EMERGENCY BOTTLE SUPPLIED SEMI-CLOSED RECIRCULATOR DURATION OF LIFESUPPORT